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AIR QUALITY ASSESSMENT
THUNDER BAY TERMINALS LIMITED
THUNDER BAY

1977

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NORTHWESTERN REGION
ONTARIO MINISTRY OF THE ENVIRONMENT

June, 1978

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SUMMARY

The Ontario Ministry of the Environment has undertaken pre-operational air and water quality assessment investigations in the vicinity of Thunder Bay Terminals Limited since 1975. This report presents results of the 1977 air quality programme, which included air monitoring and an exposure experiment with moss bags.

Dustfall levels at four sites near the project site and in adjacent residential-commercial areas of Thunder Bay sometimes exceeded Ontario regulations, but were not considered excessive. Some extremely high dustfall values were, however, recorded in the immediate vicinity of coal piles at the nearby Ontario Hydro generating station.

Concentrations of total suspended particulate, at four monitoring locations, were generally similar to those measured in 1976. Excursions above the 24-hour air quality objective were sometimes noted, but the annual objective was met at all sites.

At a nearby storage and transfer facility, a moss exposure experiment revealed the presence of elevated levels of airborne arsenic and iron, thereby confirming similar findings from snow sampling surveys in the same area in 1975 and 1976.

INTRODUCTION

Since 1975, the Ontario Ministry of the Environment has conducted pre-operational air and water quality assessment studies in the vicinity of a site designated for a coal storage and transfer operation (Thunder Bay Terminals Limited). This facility, located on McKellar Island at the mouth of the Kaministikwia River, Thunder Bay harbour, is scheduled to receive its first rail shipment of coal in June, 1978. Because the terminal project is situated near existing industrial air pollution sources, the possible effects of the latter were also considered in designing air quality investigations in the area.

Results of monitoring carried out in 1975 and 1976 are described in earlier reports (1, 2, 3). The programme for these years included vegetation, soil and snow sampling by Ministry staff and dustfall and suspended particulate measurements by V. B. Cook Co. Limited, project managers for Thunder Bay Terminals. In 1977, monitoring of airborne particulate matter was continued, and the Ministry conducted a moss bag exposure experiment around one of the nearby industries.

AIR MONITORING

DUSTFALL

Dustfall, comprising particulate matter which settles out from the air by gravity, is measured with open-top plastic jars. Following 30-day exposure periods, the collected matter is removed from the jars and weighed. Results are expressed in g/m^2 (grams per square metre) for 30 days. The Ontario air quality objectives for total dustfall are 7.0 g/m^2 for 30 days and 4.6 g/m^2, annual

average. These values are equivalent to 20 and 13 tons per square mile which were, respectively, the monthly and annual objectives before conversion to metric units in January, 1977.

Dustfall monitoring sites are shown in Figure 1. Two sites were on McKellar Island, two in an adjacent residential-commercial area of the city, and five near coal piles at the 100-megawatt Ontario Hydro generating station on Mission Island. Eight of the 9 stations were operated by V. B. Cook Co. Limited and one (site 9) was part of the Ministry's air quality network for Thunder Bay. Measurement data for all locations are summarized in Table 1. Dustfall at sites 1 to 3 sometimes exceeded the monthly objective, particularly in the summer, but average annual values were not significantly different from that recorded at the Ministry's station at McKellar Hospital. At the Ontario Hydro sites, acceptable dustfall levels were found in the winter, but extremely high values were monitored at all sites in May. Very high dustfall was also recorded from time to time from June to December. All annual averages at the generating station were above the maximum acceptable limit. Dustfall at the same sites was usually above the objective in 1975 and 1976, but average values in 1977 were much higher than those in the two preceding years. Coal dust particles were reported to be the most significant visible component of heavy dustfall deposits. Although total dustfall was sometimes very high at the Hydro sites, there is no evidence that this situation extended beyond the immediate vicinity of the coal piles.

SUSPENDED PARTICULATE

Suspended particulate matter is measured with high-volume samplers which draw a known volume of air through pre-weighed glass fibre filters for a 24-hour period. Samples are normally obtained every sixth day. After exposure, filters are re-weighed to determine the amount of dust collected. Results are expressed as $\mu g/m^3$ (micrograms per cubic metre of air) of total suspended particulate (TSP). The Ontario air quality objectives for TSP are 120 $\mu g/m^3$, 24-hour average, and 60 $\mu g/m^3$, annual geometric mean.

The 1977 data are given in Table 2 for instruments at sites 1 to 3 (operated by V. B. Cook) and site 9 (operated by Mininstry of the Environment). The 24-hour objective was exceeded occasionally at three locations and frequently at one (Shell Oil plant). The objective for annual geometric mean was met at all sites, with the mean for Shell Oil about the same as that for 1976, and those for the other three stations somewhat lower. In common with findings for many long-term surveys, TSP values were higher in spring and summer than in autumn or winter.

MOSS BAG EXPOSURE

In conjunction with investigations at Thunder Bay Terminals, air quality surveys have also been carried out in the vicinity of two nearby industries: Valley Camp Limited (a bulk storage and transfer operation), and Ontario Hydro's generating station. At Valley Camp, snow sampled in 1975 and 1976 contained significantly elevated arsenic and iron, and slightly elevated aluminum and sulphate (1,3). The presence of arsenic and iron in snow was attributed to the deposition of airborne dust from nearby piles of iron ore pellets.

To confirm the occurrence of these air pollutants in this area, a moss bag exposure experiment was conducted in the summer of 1977. Mosses are effective in absorbing and retaining some types of airborne contaminants by a passive ion-exchange process (4, 5). At Valley Camp, bags of Sphagnum moss were exposed from June 21 to July 22 at 14 sites, plus two controls. Each sample comprised about 4 g (grams) of oven-dried moss contained in a small (10 by 20 cm) envelope of fibreglass screening attached with Velcro strips to a supporting structure about 2.5 m (metres) above ground level. After exposure, samples were stored at $4^{o}C$ in polyethylene bags until processed at the Ministry's Thunder Bay laboratory. The moss was dried at $80^{o}C$ for 30 hours, then ground in a Wiley mill equipped with a 1-mm pore-size screen. Chemical analyses, by atomic absorption techniques, were subsequently performed at the Ministry's Toronto laboratory for aluminum, arsenic, calcium, iron, magnesium, potassium and sodium. These tracer elements were selected as appropriate for iron ore and coal dust.

The analytical results are presented in Table 3. Except for arsenic and iron, the concentrations of all elements were not significantly different from exposed or unexposed controls. Arsenic and iron data, plotted in Figures 2a and 2b, show that elevated concentrations of these contaminants were present at sites closest to the iron ore piles. The distribution pattern for arsenic and iron in moss was similar to that in snow (3), confirming the occurrence of a zone of contamination on and near Valley Camp property. No environmental damage from these dust emissions has yet been encountered, although residents of Mission Island have occasionally complained of airborne dust from Valley Camp operations.

ACKNOWLEDGEMENT

We are grateful to Messrs. V. B. Cook Co. Limited for providing data on dustfall and suspended particulate.

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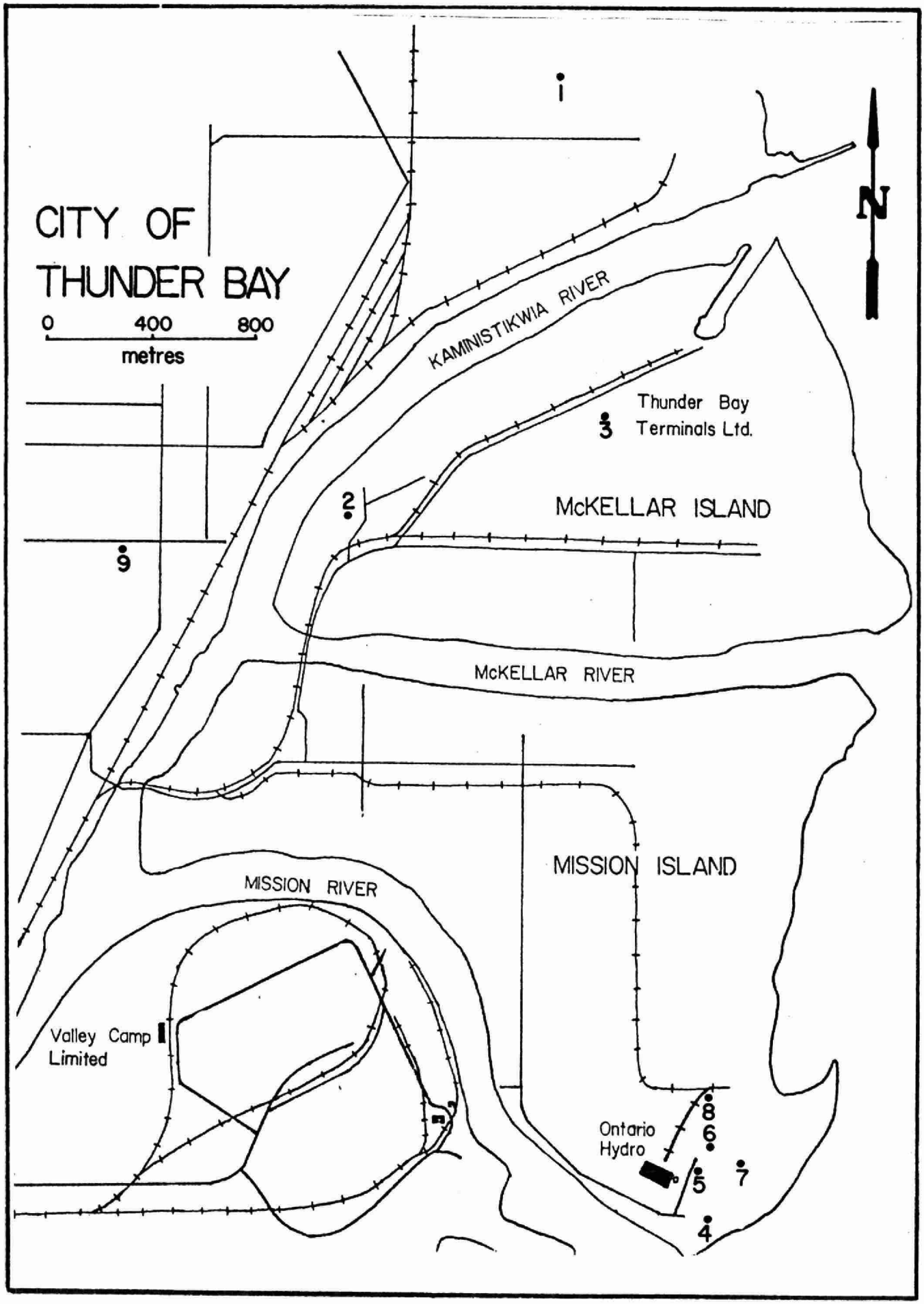

Figure 1. Air quality monitoring sites, 1977.

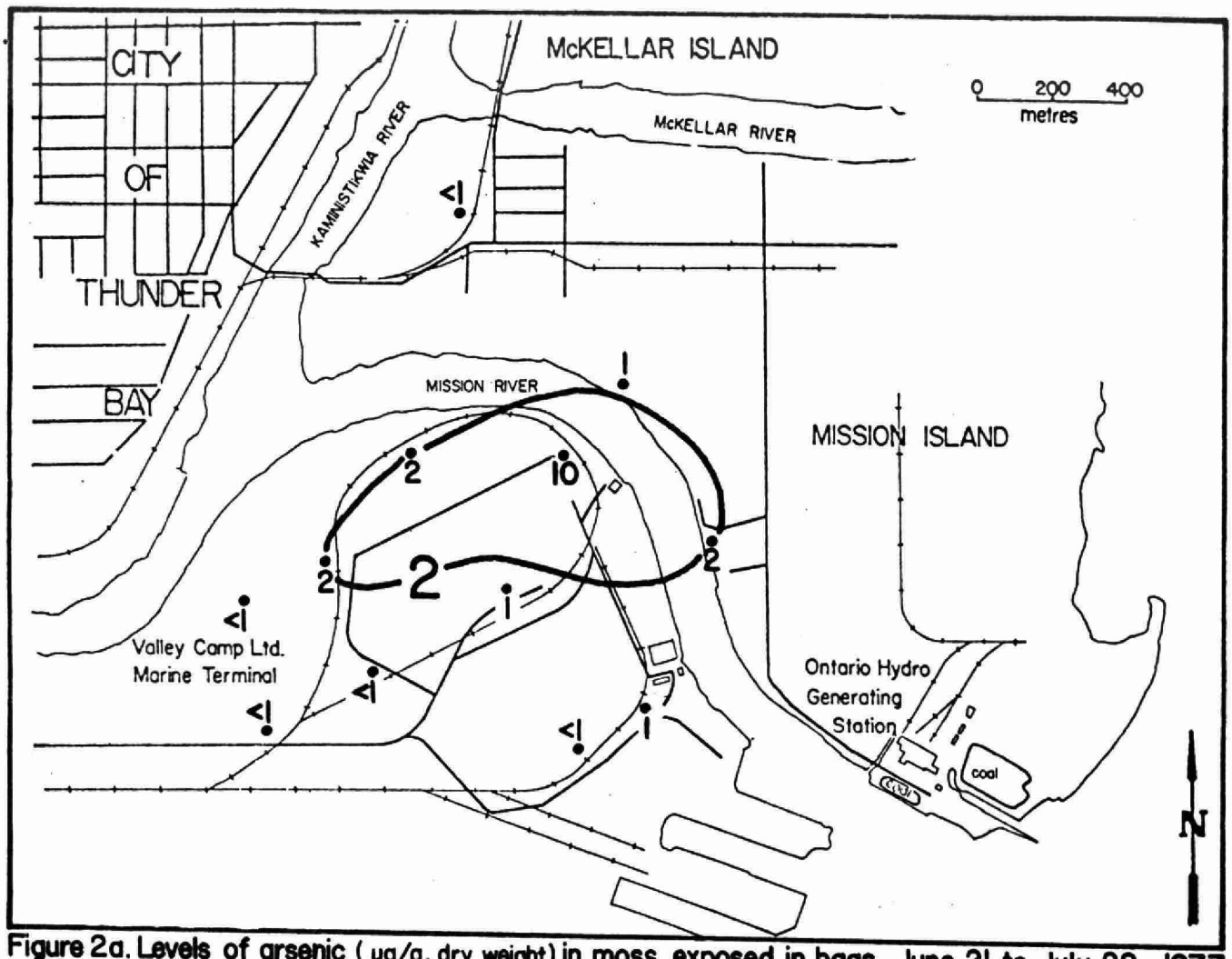

Figure 2a. Levels of arsenic (µg/g, dry weight) in moss exposed in bags, June 21 to July 22, 1977.

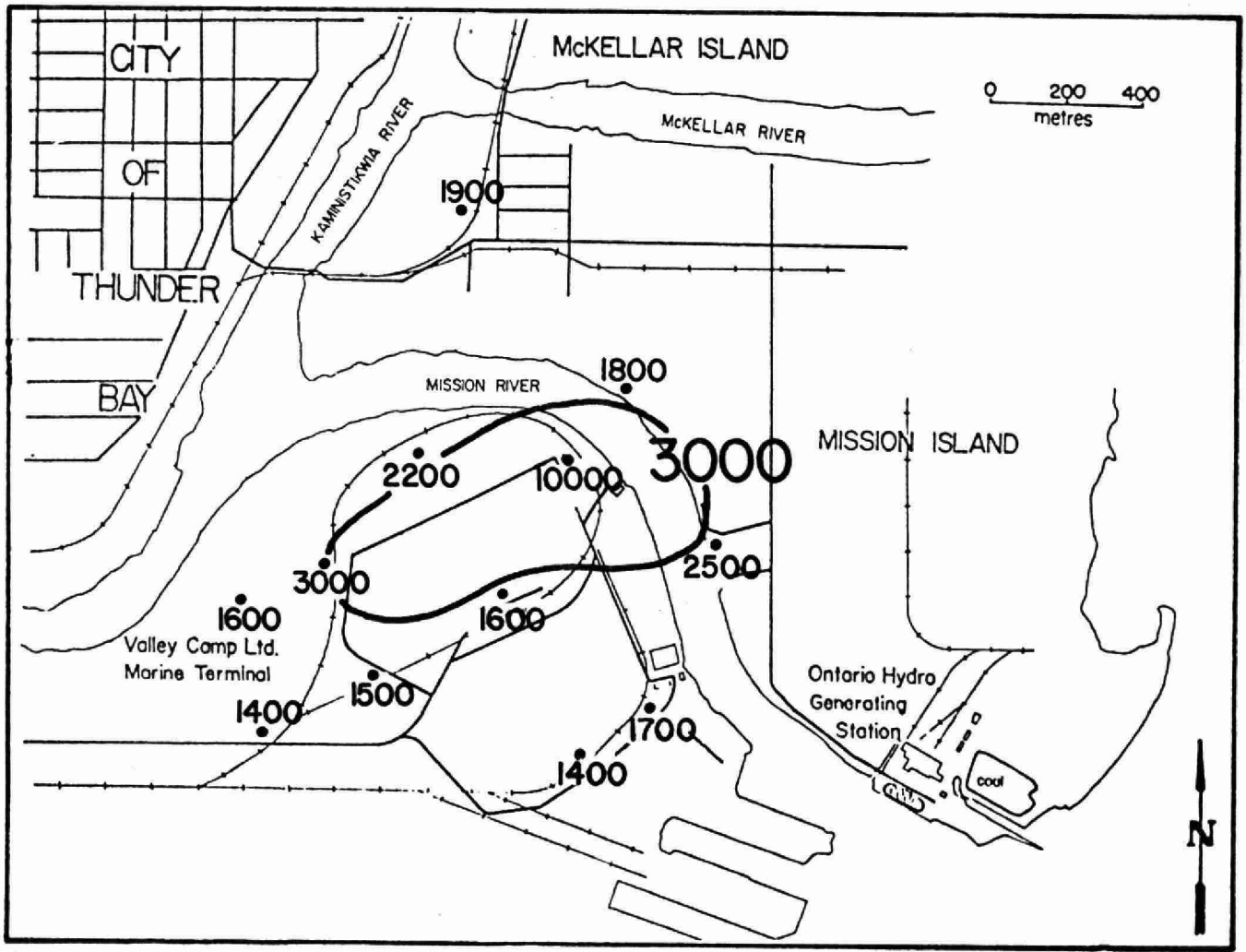

Figure 2b. Levels of iron (µg/g, dry weight) in moss exposed in bags, June 21 to July 22, 1977.

TABLE 1. Dustfall (g/m^2/30 days) in the vicinity of Thunder Bay Terminals and Ontario Hydro, 1977.

Site	Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1	Sewage treatment plant	8.8[a]	2.4	1.9	4.1	5.5	4.4	8.3	4.7	4.9	4.4	1.5	2.0	4.4
2	Shell Oil plant	5.4	4.4	4.6	6.4	10.6	11.0	10.9	14.2	9.1	15.6	4.4	3.9	8.4
3	Thunder Bay Terminals	-	4.2	2.0	2.7	4.1	4.1	5.5	10.7	5.3	3.8	2.0	1.5	4.2
4	Ontario Hydro (SE)	2.5	1.4	1.9	6.3	53.8	9.1	19.0	13.7	10.0	10.0	7.2	2.6	11.5
5	Ontario Hydro (SW)	2.7	6.9	4.8	14.9	21.2	25.2	50.5	32.2	43.4	26.1	11.3	50.0	24.1
6	Ontario Hydro (NW)	1.1	5.2	6.8	6.0	41.8	12.4	266.0	-	4.9	16.4	17.4	5.2	34.8
7	Ontario Hydro (NE)	0.6	2.3	2.2	12.9	38.4	5.0	17.6	30.5	14.7	4.7	11.2	35.7	14.6
8	Ontario Hydro (N)	2.9	2.6	1.8	3.1	10.9	6.3	6.1	13.9	5.8	2.7	-	1.6	5.2
9	McKellar Hospital	1.1	5.8	5.5	7.4	6.2	8.4	5.4	3.9	3.8	2.8	4.0	6.0	5.0

[a]Values exceeding air quality objectives of 7.0 (monthly) or 4.6 (annual average) are underlined.

TABLE 2. Levels of suspended particulate ($\mu g/m^3$) in the vicinity of Thunder Bay Terminals, 1977.

Date	Sampling site 1	2	3	9	Date	Sampling site 1	2	3	9
Jan 1	10	16	14	13	Jul 6	24	52	100	49
7	16	25	23	14	12	34	142[a]	44	-
13	58	69	90	45	18	77	175	74	123
19	42	48	54	52	24	37	63	48	37
25	20	22	13	21	30	29	30	51	29
31	22	32	25	-					
					Aug 5	48	58	59	39
Feb 6	15	26	25	38	11	31	51	31	42
12	13	20	<1	21	17	24	31	31	20
18	18	34	131	36	23	25	50	81	28
24	12	28	15	23	29	33	217	-	46
Mar 2	19	28	-	28	Sep 4	13	45	20	36
8	60	52	34	92	10	12	52	20	-
14	37	31	26	96	16	47	232	66	63
20	27	59	35	-	22	34	16	16	58
26	37	35	37	45	28	38	117	50	54
Apr 1	28	45	19	95	Oct 4	87	407	106	141
7	44	-	42	63	10	42	79	25	37
13	35	42	35	91	16	28	40	34	59
19	-	22	22	32	22	59	129	23	45
25	9	213	67	157	28	129	210	142	94
May 1	229	209	138	116	Nov 3	80	148	73	79
7	42	77	45	61	9	15	21	21	35
13	124	113	100	132	15	60	64	58	72
19	34	105	36	93	21	37	104	81	41
25	20	337	116	88	27	48	64	62	23
31	36	183	81	120					
					Dec 3	15	35	25	24
Jun 6	60	106	64	88	9	12	26	21	14
12	23	65	24	48	15	33	50	45	32
18	11	21	16	22	21	12	12	10	14
24	66	209	86	91	27	23	34	33	36
30	52	178	48	65					
					Annual geometric means:	31	60	33	36

[a]Values above air quality objective of 120 $\mu g/m^3$ (24-hour average) are underlined.

TABLE 3. Concentrations of seven elements (µg/g, day weight) in moss exposed June 21 to July 22, 1977, in the vicinity of Valley Camp Limited.

Site	Aluminum	Arsenic	Calcium	Iron	Magnesium	Potassium	Sodium
1	1400	1	2600	1700	1300	580	240
2	1600	1	2300	2300	1300	550	320
3	1700	10	2400	10000	1200	530	250
4	1400	2	2700	2200	1400	880	280
5	1500	2	2000	3000	1400	650	360
6	1300	<1	2100	1600	1400	660	220
7	1300	<1	2200	1500	1300	600	380
8	1200	1	2100	1600	1300	430	140
9	1300	<1	1600	1400	1300	580	320
10	1400	<1	2000	1400	1400	920	440
11	1400	1	2600	1800	1200	550	340
12	1500	2	2200	2500	1300	650	400
14	1500	<1	2100	1900	1200	680	770
Control	1300	<1	1800	1400	1200	670	140
Control	1500	<1	2500	1400	1200	870	95
Unexposed	1200	<1	2700	1300	1200	500	110
Unexposed	1400	<1	2600	1600	1200	570	140

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